In The Claims:

Please amend claims 1, 4 - 7, 11 - 14, 16 -19, 23 and 24 as follows:

1. (Currently Amended) A method of fuel control for synchronizing an individual engine cylinder's fuel changes to their respective changes in exhaust gases, including the steps of:

providing a catalyst for reducing exhaust gas emissions;

<u>detecting exhaust gases' conditions with a switching type oxygen sensor;</u>

correlating controlled fuel changes of individual cylinder's injectors to subsequent detected exhaust gas changes, controlled at magnitudes differing from normal operation; and

storing in memory a time delay period based upon a time difference between causing the fuel change and the detected exhaust gas property changes of the individual cylinders.

2. (Original) A method according to claim 1, further comprising the step of:

determining an oxygen sensor time response characteristics for assessing proper operating condition of the oxygen sensor using the time delay period stored in memory.

3. (Previously Presented) A method of individual engine cylinder closed loop fuel control, including the steps of:

providing a catalyst for reducing exhaust gas emissions;

detecting exhaust gases' rich or lean conditions with a switching oxygen sensor;

synchronizing a sampling time period for detecting a change in an oxygen sensor's output condition to an individually selected cylinder's exhaust gases entering the exhaust manifold;

detecting at least one engine parameter sufficient to determine stable engine operational conditions;

controlling a closed loop fuel control change in the fuel quantity during a first period to all cylinders connected to an exhaust manifold with a common oxygen sensor by using the minimum said quantity to cause sensor cycling between rich and lean conditions;

sampling the oxygen sensor's condition during a second time period when each individual cylinder's gases are entering said exhaust manifold and identifying cylinders resulting in a contrary sensor condition to the respective said closed loop fuel control changes during the first period;

controlling a minimum change in fuel quantity into at least one of the selected individual cylinders with said contrary sensor conditions, using said fuel quantity sufficient to produce a change in the oxygen sensor condition thus differing from the selected individual cylinder's exhaust gases' conditions sampled in the second time period, during a third time period;

determining the minimum change in fuel quantity causing a change in the oxygen sensor condition for each selected individual cylinder having said contrary sensor conditions follow the third time period and storing in memory such minimums for each respective individual cylinder during stoichiometric conditions; and

establishing a learned average fuel quantity offset for each individual cylinder by adjusting all cylinders' offsets such that the minimum said fuel control change necessary for each selected engine operational condition are stored in memory.

4. (Currently Amended) A method of fuel control for synchronizing individual engine cylinder fuel changes to subsequent changes in exhaust gases' conditions, including the steps of:

providing a catalyst for reducing exhaust gas emissions;

detecting exhaust gases' conditions with ~~an~~ a switching type oxygen sensor;

detecting at least one engine parameter sufficient to determine stable exhaust gases' conditions for monitoring during a first time period;

causing a sequence of changes in fuel quantity to at least one selected grouping of cylinders, during a second time period, differing from the fuel quantity in said first time period, so as to produce a change in exhaust gases' air-fuel conditions differing from the exhaust gases' conditions detected during the first time period;

monitor a time period, from a selected reference point, for the time of the first change in said exhaust gases' air-fuel conditions that are caused by said changes in fuel quantity during said second time period; and

storing in memory the monitored time period from the selected reference point.

5. (Currently Amended) A method according to claim 4, whereby the oxygen sensor ~~detecting exhaust gases' conditions is a switching type sensor having~~ has two discrete output voltage characteristics that are activated in a non-linear manner for indicating conditions richer and leaner than stoichiometric.

6. (Currently Amended) A method of transient engine fuel control compensation to selected individual cylinders, including the steps of:

providing a catalyst for reducing exhaust gas emissions;

providing a switching oxygen sensor for detecting exhaust gases' rich or lean conditions to provide engine fuel control compensation to selected individual cylinders;

detecting, during a first time period, transient engine load condition changes that may subsequently cause exhaust gases' air-fuel ratio to deviate from a defined control point;

causing a change in fuel quantities to at least one selected individual engine cylinder, differing from quantities in the first time period, during a second time period for adjusting effects of the transient engine load condition changes;

measuring effects of at least one selected individual engine cylinder's exhaust gases' conditions resulting from the changes in fuel quantity, by sampling exhaust gases' conditions with the switching oxygen sensor during predetermined time periods, following said second time period;

making subsequent modifications in fuel quantities supplied to at least a second selection of individual cylinders; and

detecting at predetermined times said second and subsequent selections of individual cylinders' exhaust gases' conditions resulting from immediately prior modifications in fuel quantities to selected individual cylinders, so as to cause air-fuel ratio fluctuations about the defined control point.

7. (Currently Amended) A method of individual cylinder fuel control compensation for conditions of engine load changes, including the steps of:

providing a catalyst for reducing exhaust gas emissions;

monitoring engine exhaust gases with ~~an~~ a switching oxygen sensor;

detecting at least one engine operating parameter indicating a load change and enabling individual cylinder fuel control;

enabling a change in fuel quantity to at least one selected individual cylinder, to produce a change in exhaust gases' air-fuel conditions that adjusts for effects of the load change;

detecting exhaust gases' conditions resulting from each said selected individual cylinders' said change in fuel quantity by sampling at predetermined times; and

controlling subsequent changes in cylinder's fuel quantity, such changes depending on effects that each previous said change in fuel quantities has on subsequent exhaust gases' air-fuel conditions detected for each individual cylinders' combustion event, to causing in cycling of gases' air-fuel about a defined control point so as to compensate air-fuel conditions for said load changes.

8. (Previously Presented) A method according to claim 7, whereby the change in fuel quantity is implemented gradually by transitioning to the maximum controlled fuel quantity changes amongst individual cylinders spanning over a number of cylinder firing events in order to minimize perceived changes in engine smoothness caused by step changes in engine cylinders' torque levels.

9. (Previously Presented) A method according to claim 7, whereby said causing cycling of gases' air-fuel about a defined control point is used to determine dynamic catalyst oxygen storage characteristics during non-stoichiometric conditions for modifying subsequent fuel changes into the individual cylinders for more quickly reaching the defined control point.

10. (Previously Presented) A method according to claim 7, wherein the changes in fuel quantity are determined using stored correction values based upon oxygen sensor feedback during prior engine load changes of similar characteristics, such said feedback from subsequent prior combustion events having said fuel quantity causing said cycling of gases' air-fuel about a defined control point.

11. (Currently Amended) A method according to claim 7, whereby ~~said~~ a second oxygen sensor is provided, and is a wide range linear type device allowing more rapid correction of measured exhaust gases' air-fuel ratio deviations from defined control points by controlling said subsequent changes in cylinders' fuel quantities depending upon actual magnitude of detected deviation from said control point.

12. (Currently Amended) A method of fuel control to compensate for undesired exhaust gas air-fuel deviations from a desired control point during engine operating condition changes, including the steps of:

providing a catalyst for reducing exhaust gas emissions;

monitoring engine exhaust gases with a switching oxygen sensor;

providing selected individual cylinder injection probe events, after a predefined number of normal fuel injection events, to have corrections in magnitudes of fuel quantity to counteract effects of load changes; and

adjusting the corrections in magnitudes of fuel quantity to selected individual cylinders, based upon the oxygen sensor feedback of exhaust gases' conditions resulting from prior said probe events by said sensor feedback sampling at predetermined times so as to cause the exhaust gases' conditions to cycle about a defined control point at an earlier time following the load change.

13. (Currently Amended) A method of early cycling an oxygen sensor's output, during non-stoichiometric transient engine load change conditions, including the steps of:

providing a catalyst for reducing exhaust gas emissions;

providing a switching oxygen sensor for detecting exhaust gases' rich or lean conditions;

causing estimated fuel changes into selected individual cylinders; and

modifying subsequently said estimated fuel changes using a successive approximation approach based upon feedback determined by sampling the oxygen sensor's output during predetermined time periods.

14. (Currently Amended) A method of fuel control for correcting fuel quantities delivered to individual cylinders prior to a detectable engine operating condition change so as to reduce undesired exhaust gas air-fuel deviations from a desired control point, including the steps of:

providing a catalyst for reducing exhaust gas emissions;

providing a switching oxygen sensor for detecting exhaust gases' conditions;

providing a device for electrically controlling engine airflow based upon operator power demands;

detecting at least one parameter indicating future power demands causing engine operation outside a defined control range based upon imminent engine operational condition changes;

delaying activating future change in the device for electrically controlling engine airflow, due to said future power demands, until after first delivering estimated modifications in fuel quantities into individual cylinders that compensate for said imminent engine operational condition changes; and

activating change in the device for electrically controlling engine airflow so as to meet said imminent engine operational condition change requirements.

15. (Previously Presented) A method according to claim 14, wherein said estimated modifications in fuel quantities into individual cylinders are modified by stored correction values, based upon fuel quantities used during prior imminent engine operational condition change events of similar characteristics, said stored correction values providing compensation during said prior engine operational condition changes based upon prior measured feedback from exhaust gases' conditions.

16. (Currently Amended) A method of rapid correction of air-fuel ratio deviations from a defined control point following an engine load change, including the step of:

providing a catalyst for reducing exhaust gas emissions;

providing a switching oxygen sensor for detecting exhaust gases' rich or lean conditions;

controlling fuel quantities, for selected individual cylinders, based upon monitoring exhaust gases' air-fuel conditions at predetermined times, in order to determine necessary fuel quantity corrections for subsequent selected individual cylinders' combustion events that will result in cycling of catalyst inlet gases' air-fuel about a defined control point.

17. (Currently Amended) A method of modifying individual cylinders' fuel control during exhaust gases' air-fuel ratio cycling to minimize levels of engine vibration perceptible to a vehicle's occupants by controlling the frequency of air-fuel cycling, including the step of:

providing a catalyst for reducing exhaust gas emissions;

providing a switching oxygen sensor for detecting exhaust gases' rich or lean conditions;

controlling frequency characteristics of engine torque fluctuations caused by engine control changes, said frequency characteristics controlled to minimize excitation of vehicle resonance points.

18. (Currently Amended) A method according to claim 17, whereby controlling of air-fuel frequency of cycling for minimizing said levels of engine vibration perceptible to a vehicle's occupants are reduced by adjusting the magnitude of engine fuel control changes versus time so as to minimize various vehicle components' resonance excitation characteristics, utilizinig information obtained from the switching oxygen sensor.

19. (Currently Amended) A method of fuel control for providing an alternative method to cycling individual engine's cylinders', or grouping of cylinders', controlled exhaust gases' air-fuel ratios between rich and lean that enter a catalytic converter connected to such cylinders, including the steps of:

providing a catalyst for reducing exhaust gas emissions;

providing a switching oxygen sensor for monitoring and detecting exhaust gases' conditions;

providing an engine configuration not needing a throttle valve for controlling engine load variations and including engine design configurations that allow controlling the intake manifold's pressure conditions to exceed those of the exhaust manifold pressure, under specified conditions; and

controlling a change to the engine's operation, during a specified time period, of said individual engine's cylinders', or grouping of cylinders', for causing gas mixtures entering into said catalytic converter having an excess of, at least, both carbon monoxide and oxygen gases, differing from normal engine operation, so as to produce catalyst heating conditions conducive to at least diagnosing of said catalytic converter's condition.

20. (Previously Presented) A method according to 19, further comprising the steps of detecting the intiation of exothermic catalyst heating following cold engine starting and causing gas mixtures entering into said catalytic converter having excess carbon monoxide and oxygen for producing catalyst heating conditions are controlled during specified engine operations for providing an early method of catalytic converter heating.

21. (Previously Presented) A method of synchronizing individual engine cylinder fuel changes to subsequent changes in exhaust gases' air-fuel conditions including:

providing a catalyst for reducing exhaust gas emissions;

detecting exhaust gases' conditions with a switching oxygen sensor;

detecting at least one engine parameter sufficient to determine stable exhaust gases' conditions for monitoring;

determining oxygen sensor conditions during a first time period;

causing a sequence of at least a first change in fuel quantity to at least one selected grouping of engine cylinders, said first change in quantity differing from a quantity present in said first time period, so as to produce at least one transition in oxygen sensor output conditions in a second time period differing from said conditions detected during said first time period;

monitoring a time period by determining a point in time of a first transition in said oxygen sensor conditions in relationship to a selected engine cycle reference datum that are caused by said changes in fuel quantity during said second time period; and

storing in memory said monitored time period.

22. (Original) A method according to claim 21, whereby additional recordings of said measured time are measured by causing a sequence of said transitions in oxygen sensor output conditions so as to determine a more accurate average for a value of said time period that can be stored in memory.

23. (Currently Amended) A method of identifying an individual cylinders' oxygen sensor's response time, when an individual engine cylinders' fuel changes cause subsequent changes in exhaust gases' conditions, including the steps of:

providing a catalyst for reducing exhaust gas emissions;

providing a switching oxygen sensor for detecting exhaust gases' conditions;

causing a sequence of at least a first and second transitions in said oxygen sensor's conditions by enabling controlled changes in fuel quantity to at least one selected grouping of cylinders;

said first transition causing a stable lean oxygen sensor condition and said second transition creating a stable, selected rich condition; and

measuring a time difference between when the first individual cylinder's exhaust gases enter the exhaust manifold having the second enabling controlled change in fuel quantity, and the actual time of said second transition in oxygen sensor output conditions resulting from said stable selected rich oxygen sensor condition.

24. (Currently Amended) A method of individual cylinder fuel control, including the steps of:

providing a catalyst for reducing exhaust gas emissions;

providing a switching oxygen sensor for monitoring and detecting exhaust gases' conditions;

compensating for transient engine load changes by delivering estimated fuel quantities into selected individual cylinders; and

modifying said estimated fuel quantities by monitoring subsequent exhaust gases' air-fuel conditions detected for the selected individual cylinders' combustion event at predetermined times, until said exhaust gases' air-fuel conditions fluctuate about a defined control point.